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Supplementary Material 2. Catalog of the 77 treadmill- and criterion-based validation studies of wearable step counting technologies that were included.

First Author and Year	Participant Characteristics	Treadmill Protocol Details	Use Video*	Analytical Procedures
Abel 2008[1]	10 men, 10 women; healthy adults; 29.4±7.1 years	3 walking bouts at 0.90-1.78 m/s; 3 running bouts at 2.23-3.13 m/s; 10 min each;	Yes	*Bias*: percent of steps taken
Abel 2011[2]	29 men, 30 women; healthy adults; 23.4±3.17 years	6 walking bouts at speeds of 0.98-0.78 m/s; 1 walking bout at a self-selected speed; 3 min each	No	*Bias*: percent error *Accuracy*: median absolute percent error
Alsubheen 2016[3]	8 men, 5 women; healthy adults; 40.0±11.9 years	3 walking bouts at a self-selected walking speed from 1.1-2.0 m/s with inclines of 0, 5 and 10%; 10 min each	No	*Other*: difference in steps
An 2017[4]	17 men, 18 women; healthy adults; 31±11.8 years	6 walking bouts with running as needed; speeds 0.89-2.24 m/s; 3 min each	No	*Bias*: Bland-Altman *Accuracy*: MAPE *Precision*: correlation *Other*: equivalence tests
Bassett 1996[5]	5 men (34.6±10 years), 5 women (33.6±16 years); healthy adults	5 walking bouts; speeds 0.90-1.78 m/s; 4 min each	No	*Bias*: percent of steps taken *Precision*: standard deviation
Beets 2005[6]	10 boys (8.3±1.5 years), 10 girls (8.9±1.7 years); healthy children; 8.6±1.6 years	5 walking bouts; speeds 0.67-1.57 m/s; 2 min each	No	*Accuracy*: MAPE
Beevi 2016[7]	9 men, 5 women; healthy adults; 29.93±4.93 years	3 walking bouts; speeds 0.28-0.83 m/s; 100 steps each	No	*Bias*: percent error *Precision*: standard deviation
Bergman 2012[8]	10 men, 10 women; healthy adults; 21.85±1.57 years	5 walking bouts; speeds 0.90-1.78 m/s; 2 min each	No	*Bias*: Bland-Altman *Precision*: standard error, correlation *Other*: difference in steps

Brown 2013[9]	15 men, 7 women; healthy adults; 28±7 years	1 constant 11-min walking bout at 1.33 m/s; up to 6 incrementally faster 2-min walking/running bouts at 0.90-3.57 m/s	Yes	*Bias*: modified Bland-Altman, percent error *Precision*: standard deviation *Other*: difference in steps
Case 2015[10]	3 men, 11 women; healthy adults; 28.1±6.2 years	2 walking bouts; speeds 1.34 m/s; 500 and 1500 steps	No	*Bias*: percent error
Chen 2016[11]	15 men, 15 women; healthy adults; 22.1±2.2 years	3 walking bouts at 0.90-1.78 m/s; 1 running bout at 2.23 m/s; 5 min each	Yes	*Bias*: Bland-Altman, percent of steps taken *Accuracy*: MAPE
Chow 2017[12]	19 men, 12 women; healthy adults; 24.3±5.2 years	5 walking bouts with running as needed; speeds 1.39-3.33 m/s; 3 min each	Yes	*Bias*: percent error *Precision*: standard deviation
Colley 2013[13]	16 men, 24 women; healthy adults; 31.1±11.2 years	4 walking bouts with running as needed; speeds of 50%-250% of self-selected walking speed; 7 min each	No	*Bias*: Bland-Altman, percent error
Connolly 2011[14]	30 pregnant women; 30.6±5.6 years	4 walking bouts; speeds 0.90-1.57 m/s; 2 min each	No	*Bias*: Bland-Altman, percent of steps taken
Crouter 2003[15]	5 men, 5 women; healthy adults; 33±12 years	5 walking bouts; speeds 0.90-1.78 m/s; 5 min each	No	*Bias*: mean difference, percent of steps taken *Precision:* correlation
Crouter 2005[16]	20 men, 20 women; overweight and obese adults; 40±13 years	5 walking bouts speeds 0.90-1.78 m/s; 3 min each;	No	*Bias*: mean difference, Bland-Altman, percent of steps taken
Dahlgren 2010[17]	12 men, 12 women; healthy adults; 22.5±2.2 years	3 walking bouts at 0.89-1.25 m/s; 1 running bout at 2.22 m/s; duration not reported	Yes	*Bias*: mean difference *Precision*: standard deviation, correlation
Diaz 2015[18]	10 men, 13 women; healthy adults; 20-54 years	3 walking bouts at 0.85-1.79 m/s; 1 running bout at 2.32 m/s; 6 min each	Yes	*Bias*: mean difference *Other*: difference in steps

Diaz 2016[19]	10 men, 13 women; healthy adults; 32±9.2 years	3 walking bouts at 0.85-1.79 m/s; 1 running bout at 2.32 m/s; 6 min each	Yes	*Bias*: Bland-Altman, percent error *Precision*: correlation
Dondzila 2012[20]	102 healthy adults; proportion female not reported; 53 from 20-69 (32.9±10.8) years, 49 from 50-80 (65.4±6.9) years	5 walking bouts; speeds 0.89-1.79 m/s; 5 min each	No	*Bias*: mean difference, percent of steps taken
Dueker 2012[21]	7 boys, 10 girls; healthy children; 12.8±1.7 years	3 walking bouts at 0.89-1.79 m/s; 1 running bout at 2.24 m/s; 3 min each	No	*Bias*: percent error *Precision*: standard deviation
Duncan 2007[22]	43 boys (19.0% overweight, 7.1% obese), 42 girls (20.0% overweight, 10.0% obese); healthy children; 36 from 5-7 (mean 6.1) years, 49 from 9-11 (mean 10.0) years	3 walking bouts; speeds 0.70-1.50 m/s; 2 min each	Yes	*Bias*: modified Bland-Altman, percent error *Precision*: loss of precision
Duncan 2017[23]	11 men, 22 women; healthy adults; 25.9±9.4 years	4 walking bouts with running as needed: speeds 0.69-2.78 m/s; 1 min each	Yes	*Bias*: modified Bland-Altman, mean difference *Precision*: standard deviation
Dwyer 2009[24]	20 men, 14 women; adults with cystic fibrosis and healthy adults; 28±7 years	1 walking bout; at a slightly faster than comfortable pace; 20 min	No	*Bias*: Bland-Altman *Precision:* correlation *Other*: difference in steps
Edbrooke 2012[25]	15 healthy adults; proportion female not reported; 22±7.8 years	4 walking bouts; speeds 0.67-1.67 m/s; 3 min each	Yes	*Bias*: mean difference *Precision*: standard error, correlation
Esliger 2007[26]	16 men, 22 women; healthy adults; 34.3±18 years	2 walking bouts at 0.83-1.38 m/s; 1 running bout at 2.2 m/s; 6 min each	No	*Bias*: mean difference, modified Bland-Altman *Precision*: coefficient of variation, standard deviation, standard error, correlation *Other*: difference in steps

Feito 2012[27]	32 men 39 women; 28 normal weight (27.8± 8.0 years), 24 overweight (34.6± 14.2 years), 19 obese (31.5±11.1 years)	3 walking bouts; speeds 0.67-1.38 m/s; 5 min each	No	*Bias*: Bland-Altman, percent of steps taken *Precision*: correlation
Feito 2012[28]	28 men, 28 women; 21 normal weight (28.3±10.5 years), 19 overweight (31.2±9.9 years), 16 obese (29.0±7.9 years)	5 walking bouts; speeds 0.67-1.38 m/s; 100 steps min each	No	*Bias*: percent of steps taken *Precision*: standard deviation
Feito 2015[29]	24 healthy adults; proportion female not reported; 23.8±8.8 years	5 walking bouts; speeds 0.67-1.38 m/s; 100 steps each	No	*Bias*: percent error *Precision*: standard deviation
Fokkema 2017[30]	16 men, 15 women; healthy adults; 32±12 years	3 walking bouts speeds 0.89-1.78 m/s; 10 min each	Yes	*Bias*: mean difference, percent error *Precision*: standard deviation, correlation
Foster 2005[31]	10 men, 10 women; 10 normal weight (30±13 years), 10 obese (32±7 years)	3 walking bouts; speeds 0.45-1.34 m/s; 15 min each	No	*Bias*: percent of steps taken *Precision*: correlation
Furlanetto 2010[32]	32 men, 28 women; 30 with COPD (67±8 years), 30 healthy (68±7) years	3 walking bouts; at 30-100% of average speed during a six-minute walk test; 1 min each	Yes	*Bias*: Bland-Altman *Precision*: standard deviation *Other*: difference in steps
Gaz 2018[33]	10 men, 22 women; healthy adults; 36±8 years	3 walking bouts; speeds 0.67-1.57 m/s; 5 min each	No	*Bias:* mean difference *Precision*: standard deviation
Giannakidou 2012[34]	24 men, 18 women; healthy adults; 22.6±2.8 years	5 walking bouts; speeds 0.9-1.78 m/s; 5 min each	No	*Bias*: percent of steps taken *Precision*: standard deviation *Accuracy*: root mean square percent error
Harrington 2011[35]	0 men, 62 women; healthy adults; 18.5±3.4 years	5 walking bouts; speeds 0.89-1.94 m/s; 7 min each	Yes	*Bias*: Bland-Altman *Precision*: standard deviation *Other*: difference in steps

Hasson 2009[36]	44 men, 48 women; healthy adults; 29±11 years; subset of 21 men, 23 women for variable speed walking condition	3 walking bouts; speeds 1.12-1.56 m/s; 12 min each; 1 walking bout variable speeds (1.12-2.50 m/s); 18 min of walking with three standing rests	No	*Bias*: percent error *Precision*: standard deviation (random error)
Hickey 2016[37]	7 men, 8 women; healthy adults; 24.9±5.1 years	3 walking bouts at 0.67-2.00 m/s; 1 running bout at 2.68 m/s; 5 min each	Yes	*Bias*: mean difference *Precision*: standard deviation
Hiebert 2010[38]	9 men, 9 women; healthy adults; 20.6±4.6 years	9 walking bouts; all at 1.48 m/s with each combination of incline (level, inclined, and declined) and footwear ("tennis shoes", "flip flops", and no shoes); 3 min each	No	*Other:* difference in steps
Hochsmann 2018[39]	6 men, 14 women; healthy adults; 10 from 18-25 (median=22) years, 10 from 45-70 (median=53) years	4 bouts; 5 min each; walking speeds 0.44-1.67 m/s	No	*Bias*: mean difference *Accuracy*: MAPE
Imboden 2018[40]	15 men, 15 women; healthy adults; 49.2±19.2 years	1 walking bout and/or 1 running bout at self-selected speeds; self-selected durations of 2-15 min	No	*Bias:* Bland-Altman, mean difference, percent error *Precision*: standard deviation, correlation *Accuracy:* MAPE
Huang 2016[41]	7 men, 3 women; healthy adults; 23.6±2.1 years	3 walking bouts; speeds 0.90-1.78 m/s; 3 min each	Yes	*Bias*: percent error
Johnson 2015[42]	20 men, 23 women; healthy adults; 20.98±1.17 years	3 walking bouts; speeds 0.89-2.01 m/s; 5 min each	No	*Bias*: Bland-Altman, percent error *Precision*: standard deviation *Other*: difference in steps
Jones 2018[43]	12 men, 18 women; healthy adults; 33±8 years	5 running bouts; 4 min each; running speeds 2.22-4.44 m/s	No	*Precision:* 95% confidence interval, correlation *Accuracy*: MAPE

Kanoun 2009[44]	9 men, 33 women; healthy adults; 23.5±4 years	4 walking bouts; speeds 0.45-1.33 m/s; 5 min each	No	*Bias*: Bland-Altman, percent error *Precision*: standard deviation *Accuracy*: MAPE
Karabulut 2005[45]	10 men, 10 women; healthy adults; 28±3.7 years	6 walking bouts; speeds 0.45-1.78 m/s; 3 min each	No	*Bias*: Bland-Altman, percent of steps taken *Precision*: standard deviation
Kumahara 2015[46]	0 men, 9 women; healthy adults; 21.6±0.5 years	4 walking bouts; speeds 0.92-1.67 m/s; 6 min each	Yes	*Bias*: percent error *Precision*: standard deviation
Larkin 2016[47]	3 men, 17 women; adults with rheumatoid arthritis; 55±14 years	1 walking bout; at a self-selected normal pace; 2-5 min (randomly selected)	Yes	*Bias*: percent error *Precision*: standard deviation, correlation *Other*: difference in steps
Le Masurier 2003[48]	13 men (30.0±6.1 years), 7 women (26.4±3.6 years); healthy adults	5 walking bouts; speeds 0.90-1.78 m/s; 5 min each;	Yes	*Bias*: percent of steps taken *Precision*: standard deviation *Other*: difference in steps
Le Masurier 2004[49]	6 men (30.5±6.6 years), 6 women (27.7±6.3 years); healthy adults	5 walking bouts; speeds 0.90-1.78 m/s; 5 min each	Yes	*Bias*: mean difference, proportion devices under/overestimating, percent error *Accuracy*: MAPE
Lee 2015[50]	22 men (20.9±1.9 years), 21 women (20.9±2.1 years); healthy adults	5 walking bouts; speeds 0.89-1.78 m/s; 3 min each	No	*Bias*: mean difference, modified Bland-Altman, percent of steps taken *Precision*: standard deviation, correlation *Other*: difference in steps
Lee 2015[51]	17 men (22.2±1.5 years), 22 women (21.1±1.6 years); healthy adults	5 walking bouts; speeds 0.90-1.78 m/s; 3 min each	No	*Bias*: Bland-Altman, percent of steps taken, mean difference *Precision:* standard error, correlation *Other:* difference in steps
Leicht 2009[52]	22 men, 24 women; healthy adults; age not reported	1 walking bout; at a self-selected normal pace; 3 min	No	*Bias*: mean difference, percent error *Accuracy*: MAPE

Leong 2017[53]	13 men, 35 women; healthy adults; 22.5±1.4 years	5 walking bouts; speeds 0.89-1.79 m/s; 3 min each	No	*Bias*: mean difference *Accuracy*: MAPE *Other*: equivalence tests
Lutzner 2014[54]	25 men, 18 women; healthy adults; 24.3±5.2 years	5 walking bouts at 0.9-1.8 m/s; 1 running bout at 2.3 m/s; 5 min each	Yes	*Bias*: Bland-Altman, percent error
Maddocks 2010[55]	15 men, 25 women; healthy adults; 28±8 years	5 walking bouts; speeds 0.6-1.4 m/s; 5 min each	Yes	*Accuracy*: MAPE *Other*: difference in steps, number of erroneous steps
Mammen 2012[56]	5 men, 5 women; healthy adults; 23±1.2 years	5 walking bouts at 0.56-1.67 m/s; 4 running bouts at 2.22-3.06 m/s; 1 min each	Yes	*Bias*: mean difference, proportion devices under/overestimating, percent error *Other*: difference in steps
Melanson 2004[57]	108 men, 151 women; healthy adults; 19-85 years; subset of 16 men, 16 women for bouts with speeds controlled across participants	2 walking bouts at a self-selected normal and brisk pace; 10 min each; 3 walking bouts at 0.45-1.16 m/s; 12 min each	No	*Bias*: percent of steps taken *Precision*: standard deviation
Mitre 2009[58]	13 men, 14 women; obese and normal weight adults; 11±1 years	4 walking bouts; speeds 0.22-0.89 m/s; 5 min each	No	*Bias*: Bland-Altman, percent of steps taken
Montes 2018[59]	26 men, 23 women; healthy adults; 23.4±6.6 years	3 walking bouts; speeds 0.67-1.57 m/s; 3 min each	No	*Precision:* correlation
Motl 2011[60]	48 men, 20 women; 24 adults with multiple sclerosis (43.5±12.2 years), 24 healthy adults (40.9±11.4 years)	3 walking bouts; speeds 0.9-1.78 m/s; 6 min each	No	*Bias*: percent of steps taken *Precision*: standard deviation
Nelson 2016[61]	15 men, 15 women; 10 healthy adults in each of three age-groups (18–39, 40–59, and 60–80 years); overall 48.9±19.4 years	1 walking bouts at a self-selected speed; 1 running bout at a self-selected speed; 5 min each	No	*Precision*: 95% confidence interval *Accuracy*: MAPE, root mean square error *Other*: number of erroneous steps

Nielson 2011[62]	50 men, 50 women; healthy adults; 23.3±3.9 years	5 walking bouts; at 80-120 steps/min; 6 min each	No	*Precision*: standard deviation *Other*: difference in steps
Oliver 2011[63]	1 men, 9 women; healthy adults; age not reported	3 walking bouts; speeds 0.90-1.78 m/s; 5 min each	No	*Bias*: Bland-Altman, percent error *Precision*: standard deviation, variance, correlation
Park 2014[64]	20 men (38.1±13.4 years), 20 women (39.1±14.0 years); healthy adults	5 walking bouts with running as needed; speeds 0.90-2.23 m/s; 6 min each	No	*Bias*: percent error *Precision*: standard deviation
Ramirez-Marrero 2002[65]	14 men, 17 women; healthy adults; 8.8±1.4 years	3 walking bouts; at a self-selected slow, normal, and fast pace; 2 min each	No	*Bias*: percent of steps taken *Precision*: standard deviation *Other*: difference in steps
Rosenkranz 2011[66]	12 men, 7 women; healthy adults; 9.6±1.2 years	3 walking bouts with running as needed; speeds 0.67-2.01 m/s; 3 min each	Yes	*Bias*: Bland-Altman, mean difference *Precision*: standard deviation, correlation *Other*: difference in steps
Rowlands 2007[67]	10 men, 0 women; healthy adults; 23.1±3.4 years	2 walking bouts at 1.11-1.67 m/s; 5 running bouts at 2.78-5.0 m/s; 1 min each; 4 running bouts at 5.56-7.22 m/s; 30 sec each	No	*Other*: difference in steps
Ryan 2006[68]	8 men, 12 women; healthy adults; 34.5±6.9 years	5 walking bouts; speeds 0.90-1.78 m/s; 5 min each	Yes	*Bias*: Bland-Altman, percent error *Precision*: standard deviation, correlation *Accuracy*: MAPE
Ryan 2008[69]	1 man, 9 women; adults with chronic lower back pain; 51±10 years	1 walking bouts at a self-selected speed; 5-6 min each	Yes	*Bias:* Bland-Altman *Precision:* 95% confidence interval

Sears 2017[70]	5 men, 5 women; healthy adults; 23.3±5.2 years	5 walking bouts; speeds 0.89-1.79 m/s; 5 min each	No	*Bias*: mean difference, percent error *Precision:* standard deviation, correlation *Other*: difference in steps
Stackpool 2014[71]	10 men (21.5±1.4 years), 10 women (22.5±1.3 years); healthy adults	1 walking bout at a self-selected speed; 1 running bout at a self-selected speed; 20 min each	No	*Bias*: percent error *Precision*: standard deviation, correlation
Stansfield 2015[72]	10 men, 10 women; healthy adults; 36±10 years	10 walking bouts; speeds 0.1-1 m/s; 5 min each	Yes	*Bias*: percent of steps taken
Steeves 2011[73]	31 men, 29 women; obese and healthy adults; 35±12.8 years; subset of 20 healthy adults for running trials	3 walking bouts at 0.89-1.79 m/s; 3 running bouts at 2.68-3.58 m/s; 100 steps each	No	*Bias*: percent of steps taken
Sushames 2016[74]	13 men, 12 women; healthy adults; 23.7±5.8 years	1 walking bout at a self-selected Borg RPE of 4; 1 running bout at a self-selected Borg RPE of 7; 6 min each	Yes	*Bias*: Bland-Altman, mean difference *Precision*: coefficient of variation *Other*: difference in steps
Takacs 2014[75]	15 men, 15 women; healthy adults; 29.6±5.7 years	5 walking bouts; speeds 0.90-1.78 m/s; 5 min each	Yes	*Bias*: Bland-Altman *Precision*: standard deviation, correlation *Accuracy*: MAPE
Tam 2018[76]	15 men, 15 women; healthy adults; 32.1±8.7 years	5 walking bouts; speeds 0.90-1.78 m/s; 5 min each	No	*Bias:* mean difference, percent error, Bland-Altman *Precision:* standard deviation, 95% confidence interval, correlation *Other:* difference in steps
Tudor-Locke 2006[77]	9 healthy adults; proportion female and age reported	1 walking bout; speed of 1.33 m/s; duration not reported	Yes	*Bias*: percent error, proportion devices under/overestimating *Accuracy*: MAPE *Other*: difference in steps

Any apparent inconsistencies in reporting of table values (e.g., age ranges vs. means, number of decimal points etc.) reflect discrepancies in reporting conventions between original articles

Ages presented as mean±SD years except where only ranges reported (min-max years) or otherwise noted

*Use of video indicates whether video back-up recording of directly-observed steps was implemented
Abbreviations: MAPE = mean absolute percentage error

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